UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Compost Contamination at UBC: An Investigation into Attitudes and Schaefer Bin Accessibility

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Compost Contamination at the University of British Columbia:
An Investigation into Attitudes and Schaefer Bin Accessibility

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Executive Summary

With various environmental thresholds being met and exceeded around the world, it is becoming increasingly important for sustainable environmental practices to be implemented at local scales. Improper waste management and disposal of biodegradable materials can lead to the production of greenhouse gasses accelerating various other environmental issues past their tipping points. At the local level, it is easier to intervene on current waste management systems and reassess how to make changes to current infrastructure and systems that enable enhanced sustainability.

The purpose of this research is to assess if compost contamination trends, at waste collection sites on the northside of academic campus at UBC Vancouver, can be explained in conjunction with waste producers attitudes towards sustainable waste practices. Data was collected through audits accessing contamination and accessibility were conducted over the course of three weeks. A quantitative survey was conducted to get data on how people on campus interacted with compost bins and policies. The audits had concluded that high contamination rates and bin fullness tended to occur near high traffic pedestrian walkways and buildings that contained food services. The survey concluded that a large portion of respondents followed composting guidelines. Respondents also indicated that unclear signage and excessive time consumption to be common motivations for compost contamination.

Keywords: compost, contamination, accessibility, waste

Introduction

The University of British Columbia (UBC) is an international institution which "is a leader in a global network of post-secondary institutions that have turned their campuses into research, development and demonstration sites for sustainable behaviour, infrastructure and community" (UBC, 2014). As such, UBC is continuously seeking new ways to investigate methods of improving daily practices which directly influence the sustainable future of the UBC Vancouver campus. Sustainability takes on many forms, however for the purpose of this research waste management practices will be investigated. This research looked to gain further insight, expanding upon what currently is available, into compost contamination at waste collection sites at UBC Vancouver. This is in support of the Social Ecological Economic Development Studies (SEEDS) sustainability program beginning the development of a waste tracking and asset management system for waste bins on the UBC Vancouver campus. This system being set up by UBC will involve a database of all bins on campus and will keep a record of the location, numbers and the weights of waste at any collection site so the university can properly distribute and adjust the number of bins according to the data received.

The area of investigation is the north side of the academic campus at UBC Vancouver. The study area is bounded by Lower Mall, Main Mall, Westbrook Mall, and the Pacific Ocean (Appendix A - *Map 1*).

Research Question & Objectives

This research project sought to examine the following question: Do the attitudes of on campus waste producers explain the trends of compost contamination across the northside of academic campus at UBC Vancouver?

Additionally, it was hypothesized that locations with high contamination also will have the highest bin fullness percentages, and bins at front of house locations are associated with higher contamination rates. Research objectives included: developing an inventory of compost schaefer bin collection sites, assessing overall level of fullness and contamination of compost bins at collection sites, gaining insight on attitudes and behaviors regarding composting and recycling at UBC, and identifying sources contributing to contamination and making recommendations to SEEDS.

To accomplish this, present literature surrounding composting and waste management practices on university campuses and elsewhere will be investigated. Next, methodologies that aim to assess the research question will be introduced and presented data analysis will aid in identifying results of significance including which compost bins are the most contaminated. Additionally, the analysis will seek to infer the nature of the contamination such as whether it took place inside the allocated building or

outside at the waste collection site. In regard to the attitudes held towards sustainable waste practices, an online survey on the topic of human interaction with compost bins and policies at UBC was used. The survey was used to gain insight into the underlying issues regarding interaction with the bins detailing the compliance with policies, issues surrounding interaction with bins and clarity around the general subject of composting. This analysis will allow us to propose several actions that can serve to mitigate the issues surrounding compost contamination.

Relevance

The relevance of this project can be defined in both a local and a global context as the problem of waste management is one that, globally, is becoming continuously more of an issue. This is a result of current methods of waste management becoming simply unsustainable and quickly exceeding current thresholds. In a global context, compostable products and food waste that are placed in landfills go through the process of biodegradation at a much slower rate and in turn create methane as a byproduct. Due to the anaerobic environment, neglecting this source of greenhouse gas can lead to various other environmental issues such as rising temperatures, increasing sea level, etc. On the other hand, composting such products and wastes can lead to the production of humus - a nutrient rich material which can help enrich soils and retain moisture, reducing the need for chemical fertilizers. Furthermore, composting can reduce methane emissions as waste goes through biodegradation in an aerobic environment and thus reduces cumulative carbon footprints. In a local context, composting is an important part of UBC's goal in the zero-waste action plan. In which UBC attempts to divert 80% of the waste produced at UBC away from landfills by 2020. Contamination of compost bins is contradictory to this goal, as highly contaminated compost bins do not get sorted out but rather placed in landfills with general waste. As a result individual carbon footprints, and that of UBC, have the ability to progressively increase.

Terminology

Schaefer Bin

A schaefer bin, at UBC, is a waste receptacle which is meant for use solely by members of UBC building operations, waste management professionals, and various other UBC staff (Appendix B - *Figure 4)*. Schaefer bins are found at waste collection sites and are where waste from inside a building gets moved to for the purpose of waste collection. These bins are not intended for external public use.

Contamination

Contamination, in compost bins, can be described as any non-compostable material found within a bin. This can include: plastics, glass, metal, etc. In the case of this research, contamination of compost schaefer bins can happen as a result of waste producers actions within a building at a sorting station, or outside of a building at a collection site.

Accessibility

Accessibility is an attribute associated with waste collection sites. This attribute describes the location and ease of potential use of compost schaefer bins. It will assess visibility and whether or not one could approach and misuse the schaefer bins.

Literature Review

Universities are the size of small cities, with thousands of students, faculty, and visitors coming onto campus each day, and they accumulate significant amounts of waste as a result. As part of the public sector and as institutions of higher education, universities have a responsibility to follow sustainable practices and engage in waste diversion whenever possible. In an effort to move towards campus sustainability, Smyth, Fredeen, and Booth (2010) conducted a waste stream analysis at the University of Northern British Columbia that involved mapping the location of all waste, recycling and compost receptacles and collecting samples for two consecutive semesters. The auditing of the collected waste revealed that 70% of the waste stream could be diverted from the landfill, with 49% being recyclable and 21% being compostable. A similar study was conducted in a smaller American university by Baldin and Dripps (2012) and produced complementary results, with only 37% of the waste stream being classified as true waste. These numbers demonstrate the importance of having recycling and composting programs at universities, as without them, all of the waste would end up in the landfill.

In order for such recycling and composting programs to be successful, however, students must be educated about the environment and care for it's well being. There is currently no existing academic literature regarding the environmental attitudes of students in British Columbia, although similar studies have been performed at other universities worldwide. Waliczek, Mcfarland and Holmes (2016) conducted a survey at two American universities regarding the campus composting programs and relevant factors such as environmental attitudes, compost knowledge, and environmental locus of control. Education proved to be a key factor - passive education through signs was highly effective, while increased compost knowledge was associated with a greater amount of compost and a more internal locus of control. In another study, the environmental attitudes of students at a New Zealand university were surveyed by Kelly, Mason, Leiss and Ganesh (2006) and there was found to be a significant correlation between

self-reported recycling behaviour and attitudes towards recycling. Attitude is referred to the opinions and beliefs that a person has towards a certain subject. Although over 98% of the respondents had positive attitudes towards recycling, only half of them answered that they were frequent recyclers. This is evidence of the value-action gap, which describes the discrepancy between perceived attitudes and actual behaviour.

The presence of a value-action gap is a topic that has received little attention in the context of recycling and composting at universities. Chung and Leung (2007) explore the value-action gap of student recycling at Hong Kong Baptist University by performing both a survey and field observations on student behaviour. The results from the survey reported that about 40% of students would recycle at least once per week. Through the field observations, however, it was found that only a tiny portion of students actually used the waste separation bins and several of those students used the bins incorrectly or caused contamination.

Contamination is an extremely important issue within recycling and composting as even one incorrectly discarded piece of waste could compromise the integrity of the entire bin's contents, thus sending it to the landfill. There has been research done on various methods of bin design to reduce contamination but due to our limited scope and timeframe, we will not be incorporating such topics into our study. Hottle, Bilec, Brown and Landis' (2015) study of three collegiate baseball games that tested the effectiveness of assigning staff to waste bins to reduce contamination. When people came up to use the bins, the staff members would help them identify and sort their waste products. As a result, contamination rates decreased significantly and there was still a reduction when the bins were left unattended during the following game. A similar study was performed at UBC by Zelenika, Moreau and Zhao (2018), wherein they examined how contamination would be affected by staffed bins, different types of bin tops and bin design. Their results corroborated Hottle et al.'s findings, with staffed bins having the most effect on reducing contamination in waste streams.

Waste management is becoming more of an important part of society in regard to the behavior and perception surrounding proper waste disposal, generation and disposal of waste continues to grow and become a larger issue. With contrasting views surrounding the practice, study into attitudes towards eco programs and their participation is extremely important. Taylor and Todd (1997) conducted a study in which researchers looked to understand consumer composting behavior corresponding to 3 models of thought. With approximately 1400 participants all of which completed a 2-week diary of their composting activities, researchers were able to conclude that people engage in environmental behavior largely for altruistic reasons and had suggested that policy regarding waste management should stress societal benefits as a means of promotion rather than personal benefits albeit some still respond to egoistic

reasoning. Ewing (2001) further looked into the behaviors behind proper waste management, mainly that of altruism, egoistic and normative behaviors of individuals. The study concluded that altruistic reasoning was a large motivating factor behind curbside recycling although there were still cases in which individuals were sensitive to inconvenience and the lack there of personal benefit.

Another important factor to recycling and proper waste management revolves around whether or not an individual has access, both spatially and socially, to a facility in which individuals are able to properly dispose of the varying types of waste they produce. Derksen and Gartell (1993) looked at the link between individual attitudes about the environment and recycling behavior by comparing separate communities with varying levels of access to recycling programs and facilities. The study indicated that individuals with access to a structured and organized recycling program have much higher levels of recycling than those who lack access to the facilities.

In the public sphere, having proper and sufficient access to waste management bins can also prove to be a factor in proper waste disposal. O'Connor, Lerman and Fritz (2010) looked at the effects of the grouping and location of bins of plastic recycling on a university campus. This was determined by observing 3 different locations across the campus and detailing the proportion of plastics disposed of in the selected bins.The study found that the placement of bins in classrooms were effective in significantly increasing the proportion of recycled plastic bottles. The study also concluded that the design of the bin was not important to the rates of recycling and proved insignificant. Jiang, et.al (2019) conducted a similar study in Japan which mainly focused on the design of the bin but contrary to O'Connor, et.al they concluded that the design had a significant effect on waste contamination ratios. Jiang, et.al's secondary objective was looking at the effect of grouping or separating bins, it was found that having different bins grouped together reduces contamination. Proper infrastructure in the public sphere is very important as implicated by Jiang et.al and, Derksen and Gartell. Miller, Meindl and Caradine studied the effects of bin proximity and visual prompts on recycling in a university building. Relative to O'Connor et al. (2010), Miller et al. (2016) had found that there was no significant difference in rates of recycling, however it would appear that even combined intervention of prompts and the grouping of bins was not sufficient to promote high levels of recycling as indicated by Jiang et al (2019).

Previous iterations of this project conducted by other students leaves much to be desired due to the nature of the project and time frame. A study conducted by students of PSYC 321 Pilat, Hogan, Ikiz, Arora and Huynh (2019) looked at the effects of visual interventions on compost bin contamination. They were unable to conclude the viability of using visual intervention as a method of reducing compost contamination. Another SEEDS project conducted by GEOG 371 students Crolla, Frier, Wat and Chow (2018) focused mainly on food packaging items and contamination at UBC, they further conducted a

survey along with other research methods looking at food purchasing habits and individual perceptions of waste sorting. They found that a large portion of contaminants are classified as food packaging and plastic utensils.

Looking at research prior to this project, it is clear that many of the studies we looked at regarding the topic are relatively old with some dating back to the 1990s. Furthermore, in a time like now where the situation seems to be in a state of constant change it is rather important that the data gets updated in order to apply a solution that can address the current problems and be flexible enough that it can be adjusted as necessary in the years to come. While there have been studies that have looked at this phenomena around the world, it would be inappropriate to generalize the findings to the inhabitants of UBC's campus. This issue in itself is in a rather gray area as nothing is a simple yes or no and thus the pursuit for more detail is never a bad thing as it simply allows us to make more informed decisions.

Methodology

For the purpose of this research, a mixed methods approach was used. This was done to create a diverse and robust platform on which analysis could be performed. This methodological approach was taken on in two consecutive phases. The first phase, data collection, was done by conducting a quantitative inventory associated with waste collection sites within the study area. Furthermore, within phase one, a survey was put out which addressed the attitudes of waste producers at UBC. The second phase involved deriving a variety of statistical summaries from both the inventory and the survey. Additionally, the second phase sought to incorporate basic correlation analysis to assess the type of relationship between different variables at collection sites.

Waste Bin Inventory

The given deliverables provided by SEEDS, which heavily relied upon the inclusion of an inventory, drove the way this initial methodology was conceptualized and carried out. To take inventory of compost schaefer bins within the study area, first academic buildings had to be located. By obtaining a building list, which included a field indicating the building type (academic or otherwise), 39 academic buildings were delineated. Using ESRI's ArcMap, the academic buildings were geocoded, and clipped to the study area. With these buildings as guidelines, waste collection sites near each building were surveyed on foot and information associated with each was recorded using ESRI's ArcGIS Collector. ArcGIS Collector is a data collection application which uses GPS. It allows users to drop pins at locations and encode associated data to each location using user created fields. Additionally, ArcGIS Collector permits the inclusion of geotagged photos (Appendix B - *Figure 2*).

The fields used for this research included: bin type, number of bins, accessibility, contamination rate, and notes. In this case the bin type was organics, and the number of bins fluctuated by collection site. The accessibility field had the ability to be filled in one of three ways: front of house, back of house, or not accessible. Front of house accessibility indicated that the collection site was located at the front of the building, and very close to and in view of major pedestrian walk-ways. Back of house accessibility indicated that the collection site was located at the back or side of the building, out of view, and not easily accessible to those who are not building operations members. Additionally, not accessible collection sites were considered to be those entirely sealed off or gated, and required keyed access by building operations members.

Furthermore, contamination was assessed visually by opening each bin at the given collection site and assigning the site as a whole a rating on a scale of 1 to 5. A rating of 1 was considered to have no present contamination, while a rating of 5 indicated extreme contamination was present. This rating system was based on the UBC waste auditing guideline provided by SEEDS (Appendix B - *Figure* 3). Using the notes field, the names of buildings associated with each collection site were recorded, and as there was no field created for bin fullness percentages the notes field was also used to record that information. Bin fullness percentages, like contamination, were assessed visually. However, for bin fullness percentages data was collected for each bin at the given collection site. Compost schaefer bins found at collection sites had markings inscribed on them which indicated where 75 percent full was, this provided a standardized guide as to how full each bin was from 0 to 100 percent.

Due to changing collection schedules and interior/exterior bin usage patterns, data was collected for all bins at each site a total of five times over the course of three consecutive weeks.

Attitudes Survey

The inclusion of a survey in this research was implemented to provide insight into the attitudes of waste producers at UBC Vancouver. A survey was chosen due to being a qualitative methodology with quantifiable responses. The survey platform used was the UBC Survey tool provided by Qualtrics. This survey aimed to target waste producers of any type including, but not limited to: students, professors, building operations staff, instructors, food services staff, and visitors. Through a short series of 18 questions this survey addressed basic perspectives and daily practices regarding waste sorting at UBC (Appendix B - *Figure 5*). The survey took less than five minutes to complete and was completely anonymous. Most of the questions were based on a Likert Scale of agreement, with answers ranging from Strongly Agree to Strongly Disagree. Additionally, distribution methods of the survey included flyers with QR codes, word of mouth, URL distribution to peers, and URL distribution on public online forums.

The responses of this survey were used to assess what people thought about UBC's current waste sorting system and how it could be improved in the future.

Statistical Summaries

Having such a large volume of data for each collection site's compost contamination and bin fullness percentages, it was essential that averages for each site be produced. For compost contamination, these averages were calculated using the following formula:

$$\frac{DAY\ 1\ RATE + DAY\ 2\ RATE + DAY\ 3\ RATE + DAY\ 4\ RATE + DAY\ 5\ RATE}{5} = Average\ Contamination\ Rate$$

*answers were rounded up to the nearest whole number

For any collection sites where data had been collected for fewer than five days, the same pattern was used but inclusive of the given number of days when collection had occurred. For example, if there were three days of collection: sum of all three rates divided by three.

Similarly, the averages of bin fullness for each site were calculated using the following steps and formulas:

1.
$$\frac{SUM\ OF\ BIN\ FULLNESS\ PERCENTAGES}{NUMBER\ OF\ BINS} = Average\ Bin\ Fullness\ Percentage\ for\ Day\ "x"$$

2.
$$\frac{AVG.\ BIN\ FULLNESS\ PERCENTAGE\ DAY\ 1 + AVG.\ BIN\ FULLNESS\ PERCENTAGE\ DAY\ 2 \ldots + AVG.\ BIN\ FULLNESS\ PERCENTAGE\ DAY\ 5}{5} = Average\ Bin\ Fullness\ Percentage$$

In the same way as the compost contamination rate averaging, for any collection sites where data had been collected for fewer than five days, the same pattern was used but inclusive of the given number of days when collection had occurred. In this case, step 1 would remain the same and step 2 would change by the number of days. For example, if there were 4 days of collection: sum all four percentages and divide by four.

Further statistical methods included correlation analysis. When assessing two variables, correlation analysis can be useful in determining what kind of relationship the variables have, if it is positive or negative, and if it is statistically significant. Basic correlation analysis yields an *r* value which is a correlation coefficient. This single statistic will fall within the range of -1 to +1, and the closer the statistic is to 0 the weaker the linear correlation is.

Ethical Considerations

Due to the nature of the project there was very little in the way of ethics to consider. A large part of the research project had no ethics to consider. Ethics come into play when there is a participant involved in the study and thus rating accessibility of schaefer bins and the contamination within them is well within ethical boundaries, especially when considering that the study took place with the backing of SEEDS.

The Survey on the other hand involved the participation of the respondents and thus is subject to research ethics. Firstly, in regard to confidentiality the survey sent out was completely anonymous and retained no information that could be used to identify participants. Secondly, in terms of security the UBC survey tool is provided by Qualtrics which complies with the British Columbia Freedom of Information and Protection of Privacy Act which secures and stores information within Canada. Lastly, the survey contained an introductory paragraph that briefed the respondents on the purpose of the study, the data that will be collected and informed them that accepting to complete the survey was the participant giving consent (Appendix B - *Figure 5*).

Results & Analysis

Waste Bin Inventory

Through the mixed methodological approach that was taken to conduct this research, an ample set of results have been established. It was found that there were a total of 28 waste collection sites within the study area (Appendix A - *Map 1*). Of these 28 collection sites, 12 (43%) are considered to have front of house access and 16 (57%) are considered to have back of house access (Appendix A - *Map 2*). Compost average contamination rates ranged from 1 to 4, with no collection sites obtaining a rating of 5 (Appendix A - *Map 3*). With respect to bin fullness averages, averages ranged from 1% to 85%. In the case of Irving K. Barber learning centre, the collection site at this location required keyed access. As a result we were unable to gain access to obtain contamination rates and fullness percentages. However, due to this research having an aim towards seeking where external contamination is happening, and this collection site being unable to be contaminated from the exterior, we do not feel as though the null results from this site have significantly skewed our research.

Furthermore, we had hypothesized that in bin collection locations where high bin fullness percentages were being recorded, that high compost contamination at such sites would also be evident. This hypothesis guided the decision to perform a basic correlation analysis between these two variables. Correlation analysis yielded a correlation coefficient (r) value of 0.475, which indicates there is a slight

correlation (a positive linear relationship) between compost contamination and bin fullness. As a result, it can be inferred that not all collection sites that have high fullness percentages have high contamination but rather, these variables tend to fluctuate. Of notable exception, Ponderosa Annex G and Hennings both proved to be sites with the highest contamination levels, and bin fullness percentages (Appendix B - *Figure 8*).

Additionally, it was hypothesized that bins at front of house locations would be associated with higher contamination rates. To investigate this, attempts at correlation analysis were made, but proved to yield irrelevant values as the sample size (number of bin locations) was far too small. In lieu of this type of quantitative analysis and due to the small sample size, results regarding this hypothesis were derived from looking at the number summaries (Appendix B - *Figure 9*). For the purpose of this analysis, high contamination was considered to be collection sites with rates 3 to 5 and low contamination was considered to be collection sites with rates of 1 or 2. One collection site, Irving K. Barber Learning Centre has been omitted due to insufficient data. Of the 12 front of house collection sites, 2 (17%) had high contamination rates and 10 (83%) had low contamination rates. Likewise, of the 15 remaining back of house collection sites, 3 (20%) had high contamination rates and 12 (80%) had low contamination rates. Consequently, there is not enough evidence to support front of house locations having higher contamination rates. However, nearly all of these front of house collection sites are located at main building entrances. Front of house collection locations which are notably close to entrances include Mary Bollert Hall, Sing Tao Building, Ponderosa Annex B, and the Abdul Ladha Science Student Centre (Appendix B - *Figures 10-13).* These sites in particular are impeding on building entrances. Although many front of house locations are found farther away from the central, busy areas of campus, re assessing where these front of house locations are relative to their respective buildings would likely have the ability to deter the misuse of bins and give building users an increasingly pleasant experience when entering the building.

Attitudes Survey

The survey was published for approximately four weeks and received thirty respondents, 93% of whom were UBC students and 67% of whom were in their 3rd or 4th year. An overwhelming majority of respondents stated that following composting and recycling practices was important to them and moreover, all respondents at least somewhat agreed with the statement “I follow UBC’s sorting guidelines for food scraps”. While encouraging to hear, this response is clearly not representative of the entire UBC population as there is still a notable level of contamination in the compost bins.

When asked about challenges faced when sorting waste, respondents commonly mentioned that it was time consuming and that unclear or confusing signage was an issue. 50% of respondents either somewhat agreed or strongly agreed that sorting waste was not a priority when they were in a rush. While the quantity of signage at waste bins did not seem to be a problem, the quality of the signage raised concerns. Several respondents commented that they liked the signage used in the Life Building, which has displayed examples of common items that go into each bin.

The main purpose of the survey was to gain a general understanding of attitudes towards waste sorting at UBC and identify potential motivators for contamination. While 87% of respondents agreed that protecting the environment and living sustainably was important to them, only 54% of them believed that their individual actions would make a difference regarding climate change. This low environmental locus of control likely affects how willing people are to sort their waste or to just throw it all into one bin. In addition, 60% of respondents at least somewhat agreed that they were more likely to sort their waste when other people were around. However, the presence of existing contamination in the bin did not seem to have an effect on how likely a person was to properly sort their waste.

Limitations

Due to the nature of being confined to a single semester, the research project was rather limited in its scope. The findings will be largely applicable to only the UBC Vancouver campus and will not be representative of the surrounding area, especially since UBC and the City of Vancouver employ different waste sorting practices. In addition, this research project only covered the northern half of campus, while the southern half was studied by another group in the class.

The data gathered from the bin collection sites may not be fully representative due to the methodology used. Although UBC Waste Management emptied bins throughout the week, data was only collected on two days of the week (Wednesday, Thursday) as a result of our constrained schedule as students. However, we repeated this data collection over three consecutive weeks in order to increase accuracy and reduce the impact of outlier data. In addition, certain areas (Life Building and IKB Learning Centre) were restricted to waste management staff only and thus there was partial/no data collected for these two buildings.

The level of bin fullness and contamination were only assessed on a surface level by opening the lid and eyeballing the contents. Using a weight scale or emptying out the bins would have yielded more meaningful data, but both time and money were constraining factors. Furthermore, the bin fullness and contamination data was gathered by three different researchers. While a common scale was agreed upon and used, there is still an unavoidable level of subjectivity in the results.

Analysis of the collected data proved to have its limitations as well - the attitudes survey had a low sample size of thirty respondents, which was made up of a narrow demographic (students in their 3rd or 4th year at UBC). Moreover, in many cases, it was impossible to ascertain if the contamination found in the bins was a result of interior or exterior bin usage. An observation of highly contaminated bins was planned to take place to remedy this fact, but it was ultimately cancelled due to the COVID-19 outbreak and subsequent campus closure.

Discussion

In summary, trends of compost contamination across the northside of academic campus were quite variable. Contamination rates were generally similar across both front of house and back of house collection sites, but there was variability at individual sites throughout the five data collection days. Additionally, waste producers' attitudes towards sustainable waste practices also seemed to fluctuate. While overall contamination within the study area may be considered low, it is apparent from many survey responses that significant proportions of waste producers do not believe their individual actions are making impacts. This is an important factor to take into consideration as this overarching viewpoint likely drives many of the ways, whether it is realized or not, that people interact with waste on a daily basis. While most people did not indicate major issues when sorting waste, there are definitely improvements to be made to the current waste sorting system, especially regarding ease of use and type of signage.

Conclusions & Recommendations

A large portion of the bin collection locations (43%) were identified as FOH, meaning that they were easily accessible to the public. People walking by would be able to open the bins and throw in waste, thus causing contamination. Evidence of this was seen during the data collection phase. For example, plastic bags and tree branches were found within bins. In order to deter external bin use, it is suggested that some sort of visual or physical blockade be constructed to reduce access at the FOH locations. A locked fence system is already in place at the Irving K. Barber Learning Centre and a similar setup could be implemented at other publically accessible locations on campus. Locations where we recommend enclosures or partitions to be implemented include: Mary Bollert Hall, Ponderosa Annex B, Sing Tao Building, and Abdul Ladha Science Student Centre (Appendix B - *Figures 10-13*).

Looking at the bin fullness percentage data, the Henry Angus Building (Sauder) has 14 compost bins but only an average fullness percentage of 14%. During the five separate times that data was collected at this site, there were always at least 10 empty bins. Some of these extra bins could be removed

from the Henry Angus Building and be reallocated to high fullness percentage locations such as the Hennings Building and Ponderosa Annex G.

Improper disposal of food and drink containers were the most common type of contamination observed inside the compost bins. This included styrofoam containers with food scraps inside, or non-compostable coffee cups. The results from the survey indicated that this contamination may be due to confusing or unclear signage. For example, compostable coffee cups (UBC Food Services) should go into the Food Scraps section and non-compostable coffee cups (Tim Hortons, Starbucks) should go into the Recyclable Containers section, however there is no distinction between the two types of cup on the current signage. Instead, all coffee cups are directed into the Recyclable Containers bin. We recommend that signage located at the sorting bins be updated to be easier to understand and to reduce contamination. In addition, several survey respondents suggested that they would like to see the signage currently used at the Life Building to be implemented into other buildings on campus. This signage contains physical examples of popular items that go into each bin and serves as a helpful visual indicator for which item goes where. These waste samples may be especially helpful for first-year students who are new to UBC and may be used to other sorting systems used elsewhere.

Future Research

Under different circumstances, we would like to proceed with the observational based research of composting behaviour. This would provide further insight into why bin contamination is happening and if it is occuring from interior or exterior bin use. For a more accurate analysis of bin fullness and contamination, a weight based audit may be performed using an industrial scale.

An in depth campus-wide waste audit could also be performed by emptying out waste bins and sorting the contents by hand. By determining the most common types of waste and contamination in the bins, it would be simple to figure out what items are being commonly missorted. Although lengthy and logically complex, this potential project would provide valuable insight into sources of contamination , and may be useful in improving bin signage as well. This could be conducted on one or two routes per group as it would allow for more time to be spent on a single route.

An in depth look into student and staff narratives around composting and recycling could prove useful as it could expose problems that administrators might not see. This can take place in the form of a qualitative survey with incentive and an interview for more detailed individual experiences. This could be useful because it would allow students and staff the ability to voice concern over certain aspects of user interaction, for instance not knowing where to put a coffee cup since there are both compostable and non compostable versions.

Experimentation of different types of signage can be carried out to address the finding of confusing signage being a cause for concern from the survey. This can be done in buildings with moderate to high contamination rates and tracked by either a waste audit or an observation of interactions with the compost and waste bins. This could prove useful as it would determine whether visual guides are effective or not, in addition to this it could determine whether more detailed or simplistic visual guides are effective.

Another experiment would be to look at the positioning and grouping of waste bins, as indicated by our literature review many do not recycle properly due to the insufficient waste management facilities. Thus assessing, waste management facilities in high pedestrian traffic walkways might help with reducing general waste.

Conducting a study with similar methodology to this project for on campus residences may also prove useful, this project both assesses waste contamination and allows for the tracking of waste bins in dormitories to add to the inventory count for the waste tracking and asset management systems. With a better view of the whole campus SEEDS and the administration would be able to better make changes to reflect the high contamination areas.

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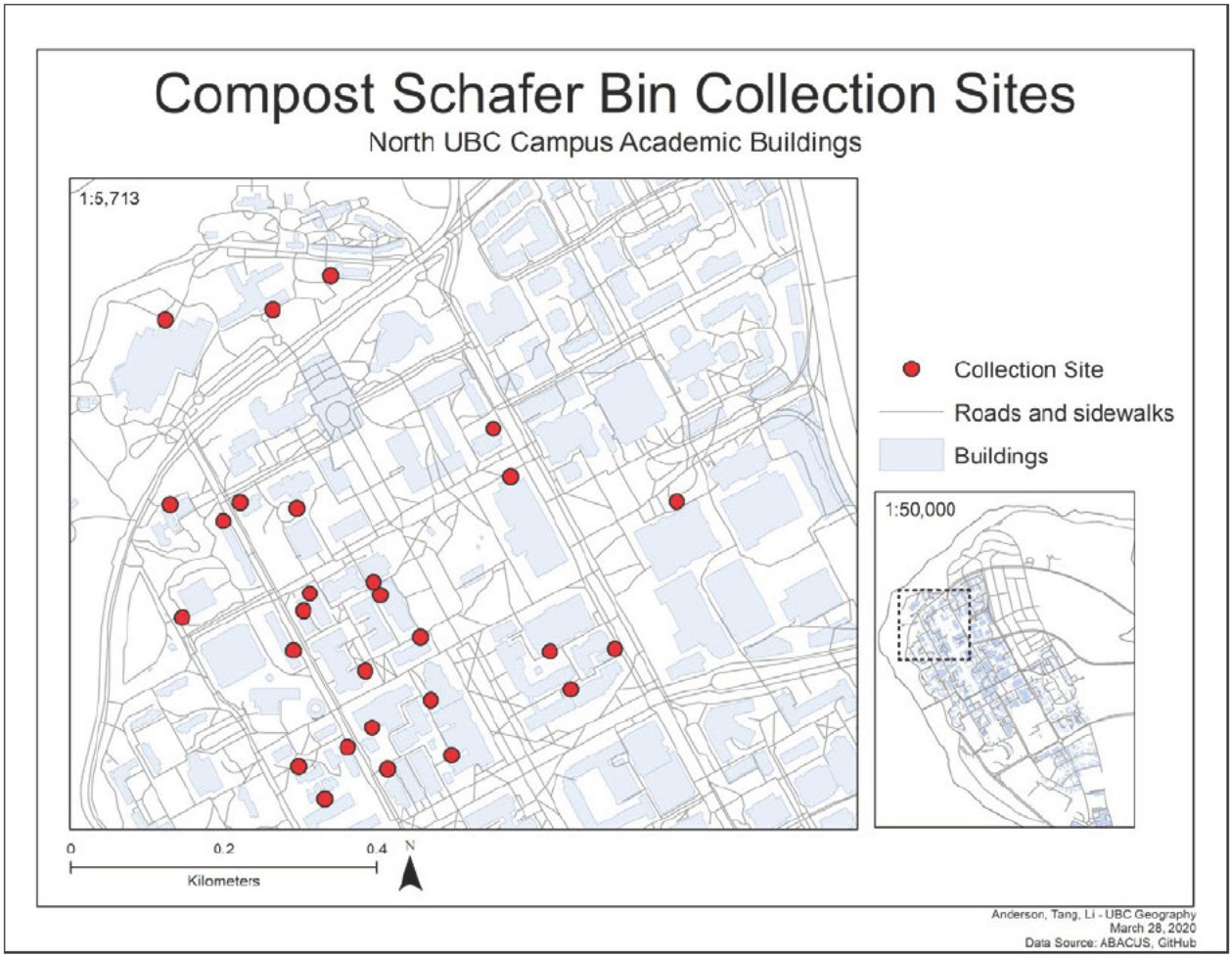
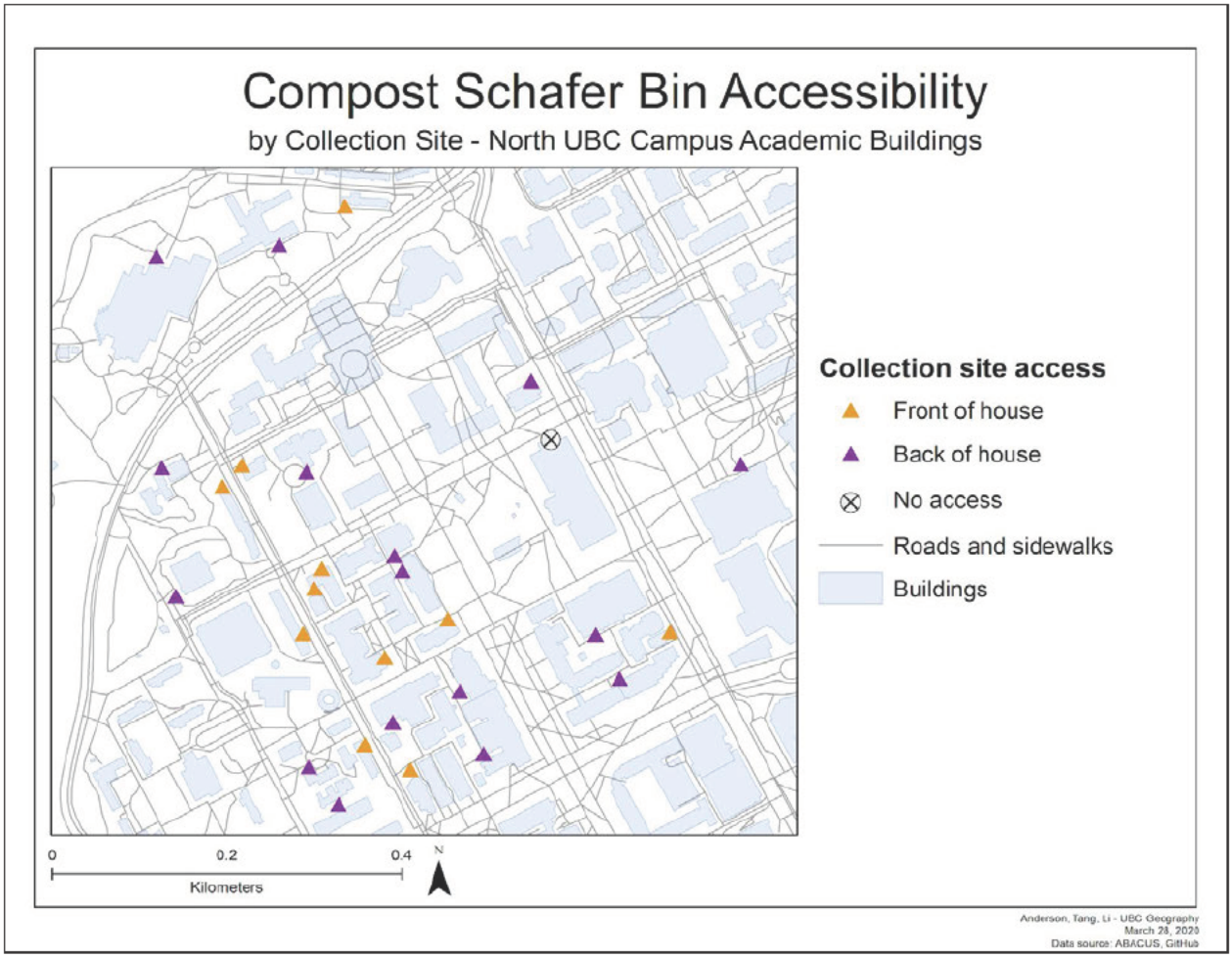
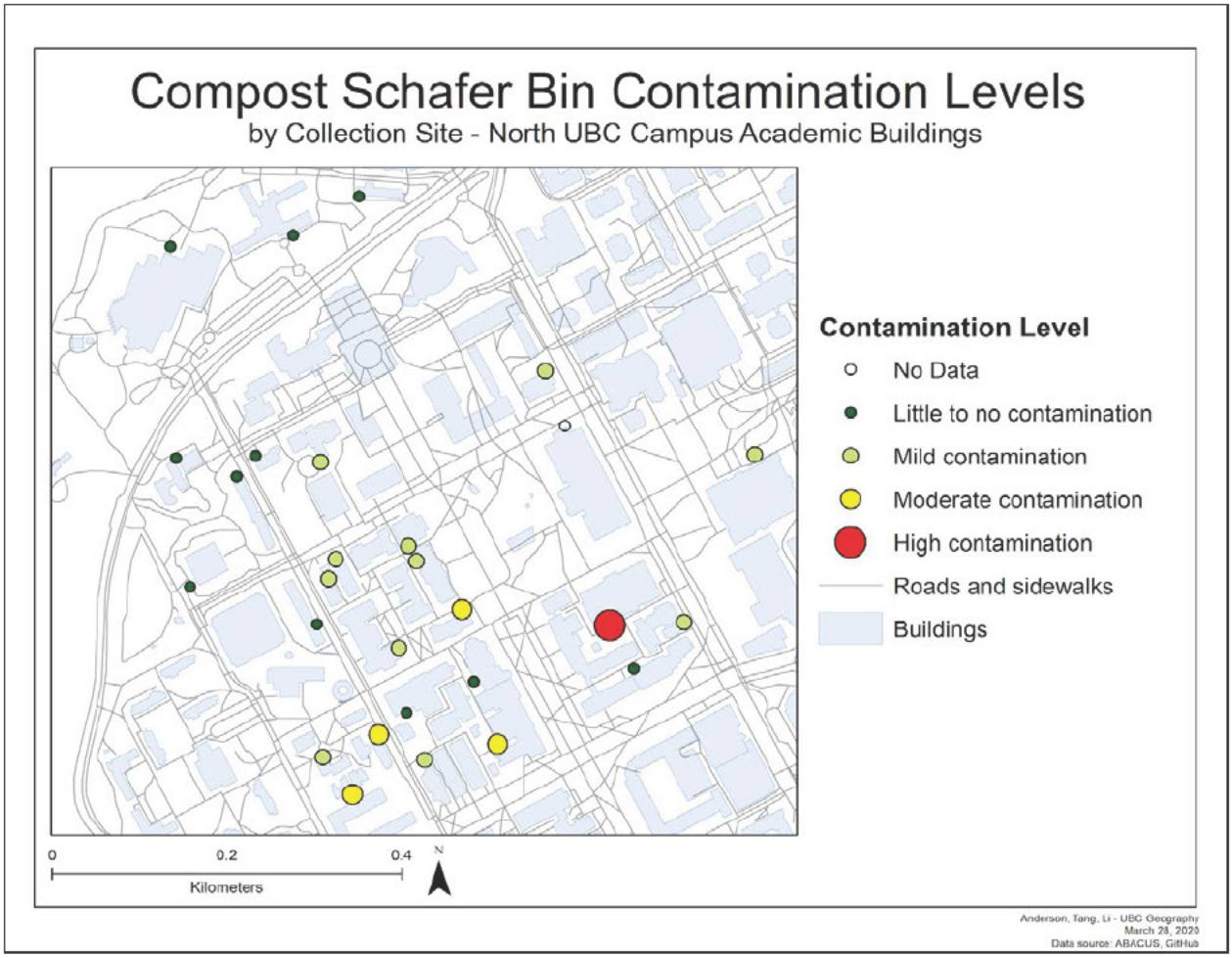
Appendix A



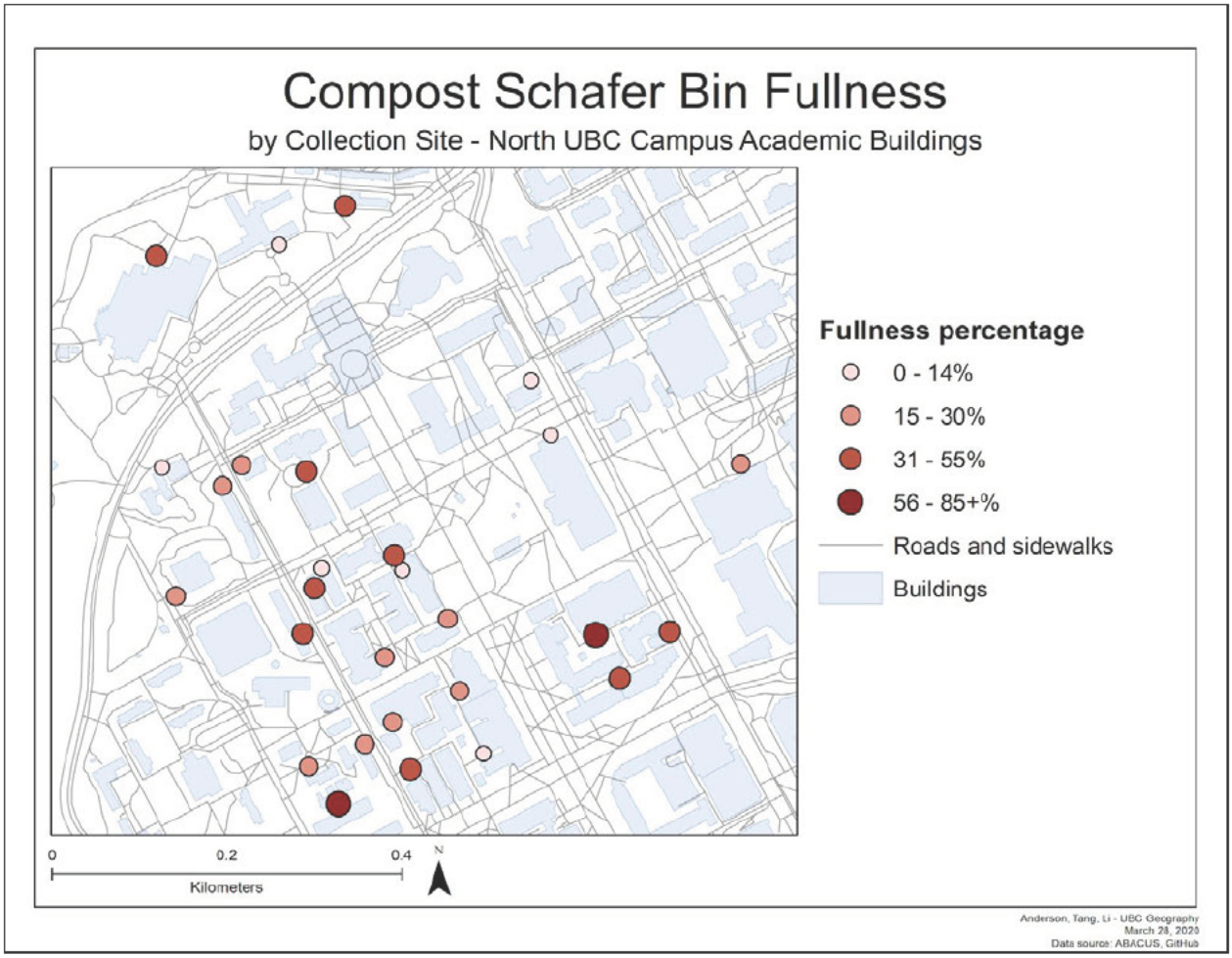
Map 1 - Compost schaefer bin collection sites at academic buildings on the north side of campus at UBC Vancouver.



Map 2 - Accessibility at compost schaefer bin collection sites.



Map 3 - Average contamination levels at compost schaefer bin collection sites. Contamination rankings have been displayed with high contamination as a max, corresponding to the given rate of 4. See Appendix B - *Figure 2*.



Map 4 - Average fullness percentages of compost schaefer bins at collection sites.

Appendix B

Building Name	Site	Accessibility	Bin Count	Average Contamination Rate	Average Bin Fullness Percentage
Abdul Ladha	1 of 1	FOH	3	2	35%
Anthropology and Sociology Building	1 of 1	FOH	2	1	8%
Asian Centre	1 of 1	BOH	2	1	28%
Auditorium Annexes (site 1)	1 of 2	FOH	1	2	52%
Auditorium Annexes (site 2)	2 of 2	FOH	1	2	9%
Buchanan	1 of 1	BOH	9	2*	13%
Chemistry South Wing	1 of 1	BOH	1	1	55%
CK Choi Building	1 of 1	FOH	2	1	16%
David Lam	1 of 1	BOH	1	1	21%
Geography	1 of 1	FOH	3	2	23%
Hennings	1 of 1	BOH	4	4	85%
Henry Angus Building (Sauder)	1 of 1	BOH	14	3	14%
Irving K. Barber Learning Centre	1 of 1	BOH	4	N/A	N/A
Jack Bell Building	1 of 1	FOH	3	2	34%
Koerner Library	1 of 1	BOH	2	1*	1%
Leonard S. Klinck Building	1 of 1	BOH	3	1	18%
Life Building	1 of 1	BOH	29	2*	22%
Liu Institute for Global Issues	1 of 1	BOH	1	1	8%
Mary Bollert Hall	1 of 1	FOH	1	1	37%
Math Annex	1 of 1	FOH	1	3	30%
Morris and Helen Belkin Art Gallery, Fredrick Lessare, Music Building	1 of 1	BOH	2	2	45%
Museum of Anthropology	1 of 1	BOH	2	1	41%
Old Administration Building	1 of 1	BOH	2	2	37%
Ponderosa Annex B	1 of 1	FOH	1	3	19%
Ponderosa Annex E+F	1 of 1	BOH	2	2	22%
Ponderosa Annex G	1 of 1	BOH	9	3	63%
Sing Tao Building	1 of 1	FOH	1	1	27%
West Mall Annex	1 of 1	FOH	1	1	42%

Figure 1 - Compost schaefer bin inventory table. * indicates that this collection site had less than 5 days of data gathered for it due to accessibility issues or missing bins, N/A indicates there was not sufficient data collected for the value to be significant. See Appendix B - *Figure 2* for descriptions on how average bin contamination rates and average bin fullness percentages were calculated.

Figure 2 - ArcGIS Collector app example.

Method 1: Sorting and Contamination Visual Audit

This method is the least effort to assess sorting accuracy and contamination, and be accomplished in a situation where there is no opportunity to study bin contents in detail including weighing. It provides data that is more qualitative and thus less accurate, less reproducible and less suitable to determine statistical significance.

Metrics:

1. Contamination score: since this method does not necessarily count all the contaminants within the bin contents, it will be based only on what is visible and provide a unitless metric – e.g., scored as 1 to 5 with 1 being no contamination and 5 being the highest level of contamination. Or alternatively, a % sorting accuracy could be estimated.

Method:

1. Visually assess the contaminants in the bin, either what is readily visible or throughout the contents (if this is feasible) and assign a contamination score. It is important to score the bins as consistently as possible across trials and across different auditors.
2. Increasing the number of visual assessments to increase the sample size to as large as possible will help to increase the validity of the data.

Examples of very heavily contaminated food scraps bins

Figure 3 - UBC Waste Auditing Guideline, Method 1 - obtained from SEEDS, created by UBC sustainability.

Figure 4 - Schaefer bins.

"The purpose of this survey is to find out the behaviors and attitudes held towards composting and proper waste management here at the University of British Columbia. The survey results gathered will go towards helping UBC improve and change its waste management system and policies. Accepting to partake in the survey will signify your consent being given."

Figure 5 - Survey Introductory Paragraph.

1. What is your affiliation with UBC?
    a. Student
    b. Professor/ Instructor
    c. Staff
    d. Other (visitor, prospective student, parent, visiting academic, etc. – please specify)

2. How long have you been at UBC regularly? (On campus at least 3 days/week throughout the year)
    a. Less than 1 year
    b. 1-2 years
    c. 3-4 years
    d. 5+ years
    e. Not applicable

3. Where do you live?
    a. Live off campus
    b. Live in residence
    c. Other (not in Lower Mainland)

4. I am well informed on composting and recycling practices at UBC.
    a. Strongly disagree
    b. Somewhat disagree
    c. Neither agree nor disagree
    d. Somewhat agree
    e. Strongly agree

5. Following composting and recycling practices is important to me.
    a. Strongly disagree
    b. Somewhat disagree
    c. Neither agree nor disagree
    d. Somewhat agree
    e. Strongly agree

6. I follow UBC's sorting guidelines for food scraps as show in the graphic below:

    a. Strongly disagree
    b. Somewhat disagree
    c. Neither agree nor disagree
    d. Somewhat agree
    e. Strongly agree

7. The buildings that I frequent have signage detailing instructions for composting/recycling disposal.
    a. Strongly disagree
    b. Somewhat disagree
    c. Neither agree nor disagree
    d. Somewhat agree
    e. Strongly agree

8. Which buildings need more/better signage? (Optional)

    _____

    _____

9. I try to use reusable containers whenever possible.
    a. Strongly disagree
    b. Somewhat disagree
    c. Neither agree nor disagree
    d. Somewhat agree
    e. Strongly agree

10. I try to avoid using containers/packaging that is not recyclable or compostable (Styrofoam containers, plastic bags, aluminum foil)
    a. Strongly disagree
    b. Somewhat disagree
    c. Neither agree nor disagree
    d. Somewhat agree
    e. Strongly agree

11. Protecting the environment and living sustainably is important to me
    a. Strongly disagree
    b. Somewhat disagree
    c. Neither agree nor disagree
    d. Somewhat agree
    e. Strongly agree

12. My individual actions do not have an impact on climate change at the local or global scale.
    a. Strongly disagree
    b. Somewhat disagree
    c. Neither agree nor disagree
    d. Somewhat agree
    e. Strongly agree

13. I am more likely to sort my waste when other people are around.
    a. Strongly disagree
    b. Somewhat disagree
    c. Neither agree nor disagree
    d. Somewhat agree
    e. Strongly agree

Figure 6 - Survey questions.

14. I feel that sorting waste is difficult.
    a. Strongly disagree
    b. Somewhat disagree
    c. Neither agree nor disagree
    d. Somewhat agree
    e. Strongly agree

15. What are some challenges you face when sorting waste? (Select all that apply)
    a. Lack of signage
    b. Signage is unclear
    c. Not enough bins
    d. Bins are not easily accessible
    e. Time consuming
    f. I do not know how to sort waste
    g. Other (please specify)
    h. I don't have any trouble sorting waste

16. If I am in a rush, sorting my waste is not a priority.
    a. Strongly disagree
    b. Somewhat disagree
    c. Neither agree nor disagree
    d. Somewhat agree
    e. Strongly agree

17. I am less likely to recycle/compost correctly if there is already visible contamination.
    a. Strongly disagree
    b. Somewhat disagree
    c. Neither agree nor disagree
    d. Somewhat agree
    e. Strongly agree

18. Do you have any comments on UBC's composting system can be improved? (Optional)

    _____

    _____

Figure 7 - Survey questions (cont.)

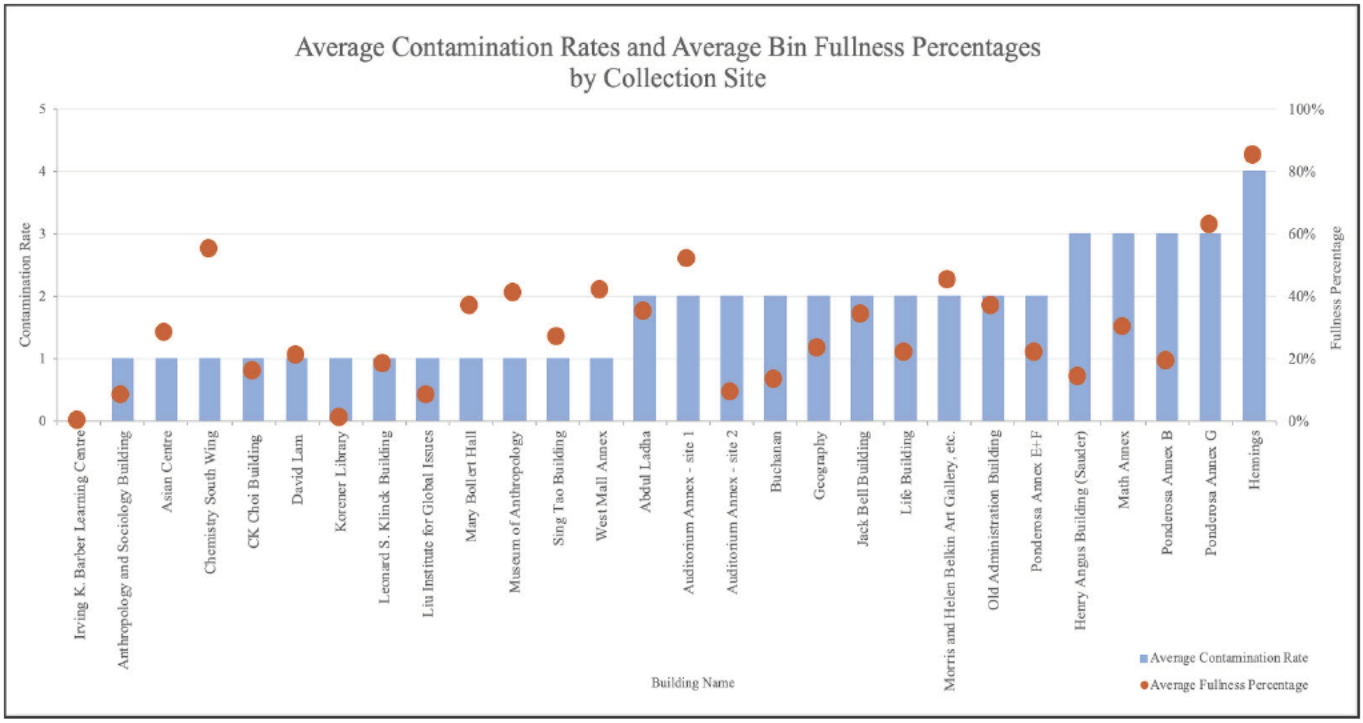


Figure 8- Average contamination rates and average bin fullness percentages by collection site.

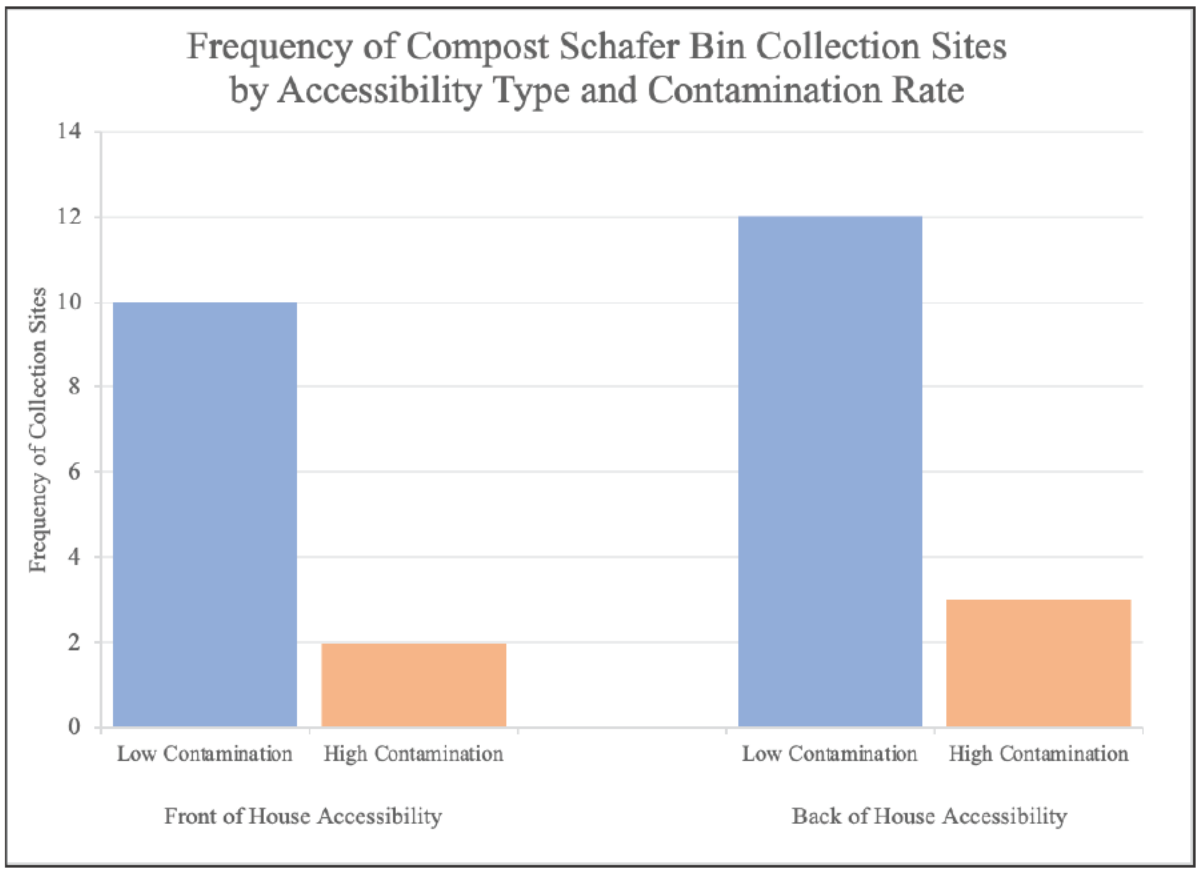


Figure 9 - Frequency of compost schaefer bin collection sites, by accessibility type and contamination rate. * note that one BOH site had a N/A rating and as such has been omitted.

Figure 10 - Mary Bollert Hall - Front of house collection site.

Figure 11 - Ponderosa Annex B - Front of house collection site.

Figure 12 - Sing Tao Building - Front of house collection site.

Figure 13 - Abdul Ladha Science Student Centre - Front of house collection site.